Community Atmosphere Model - Finite Volume Dynamical Core
CAM-FV

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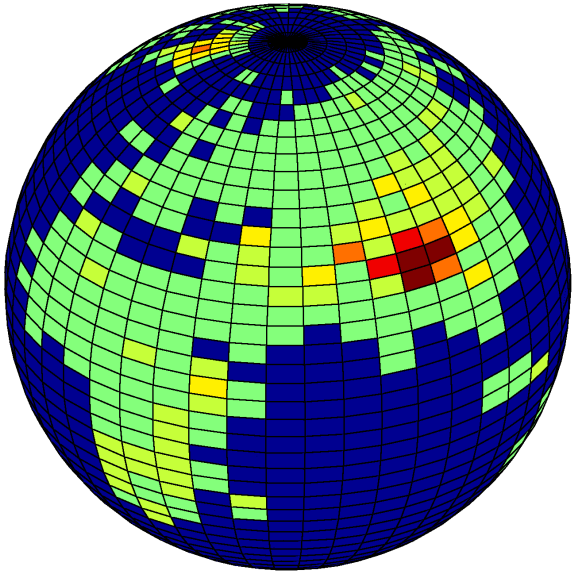
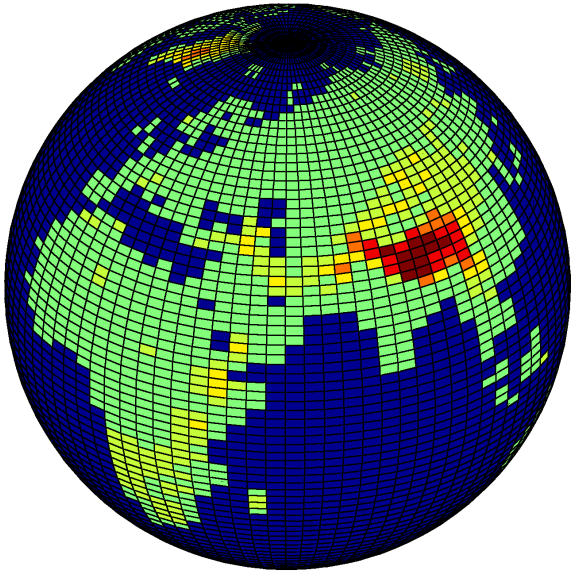
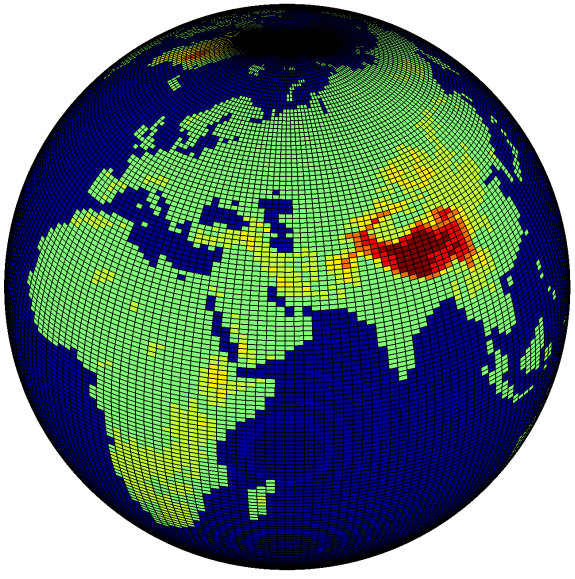
August 2012

CAM-FV: Overview

- Focus on transport - finite-volume methods
- Treat momentum, thermodynamic and tracer equations consistently
- Lagrangian vertical coordinate
- Default dycore in CAM5

Equation Set

- Hydrostatic Primitive Equations
- Solve for u, v, θ, δp (pressure thickness), q (tracers)

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- Solve for u, v, θ, δp (pressure thickness), q (tracers)
- Vector-Invariant form of equations (in 2D)

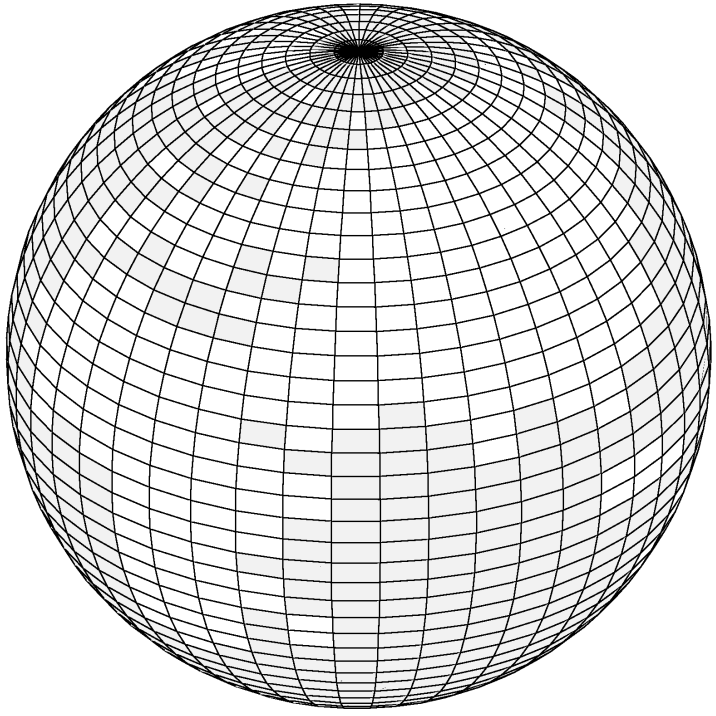
$$\frac{\partial u}{\partial t} = \Omega v - \frac{1}{a \cos\phi}\left[\frac{\partial}{\partial \lambda}\left(K + \Phi - \nu D\right) + \frac{1}{\rho}\frac{\partial p}{\partial \lambda}\right]$$

$$\frac{\partial v}{\partial t} = -\Omega u - \frac{1}{a}\left[\frac{\partial}{\partial \phi}\left(K + \Phi - \nu D\right) + \frac{1}{\rho}\frac{\partial p}{\partial \phi}\right]$$

- Accurate advection of vorticity (Ω)

Latitude-Longitude Grid

- Makes use of lat-lon grid
- Use of flux-form semi-Lagrangian (ffsl) method reduces impact of pole problem
- Computes latitude bands in parallel



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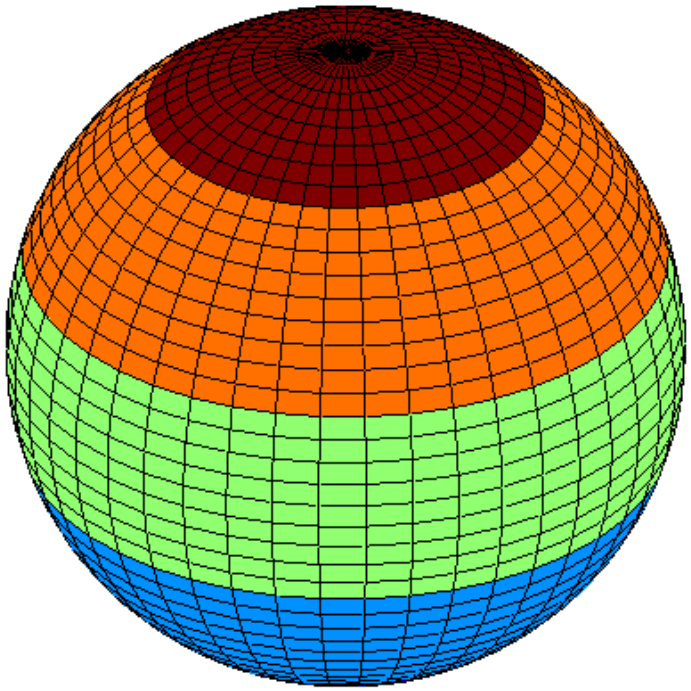
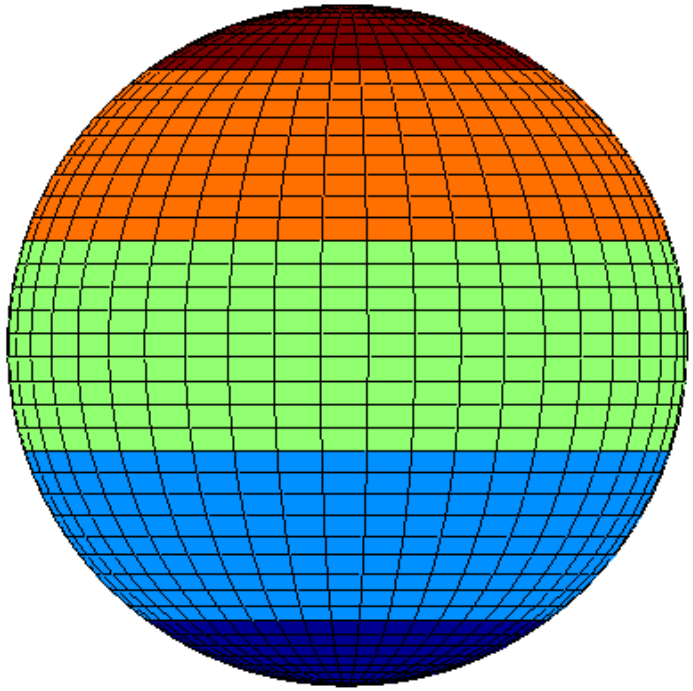
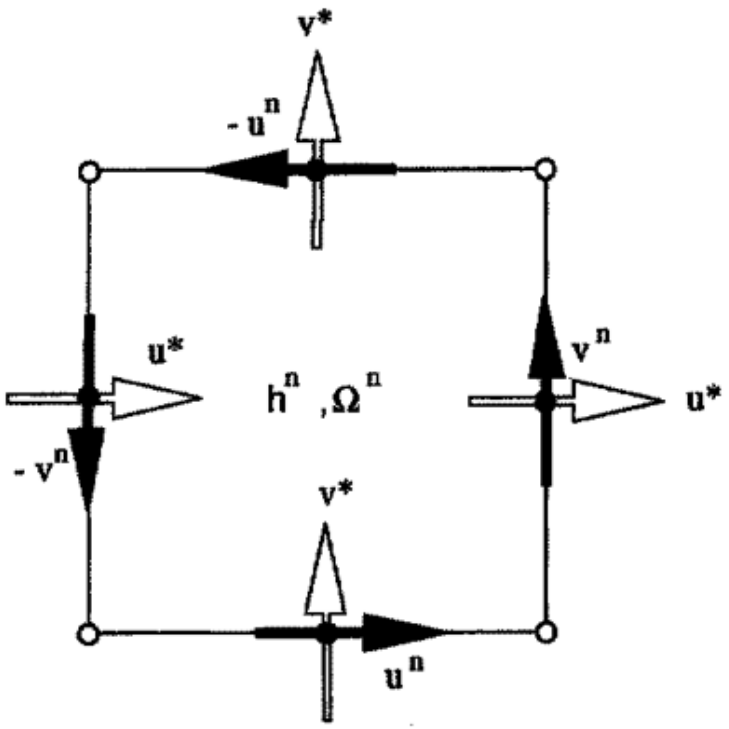




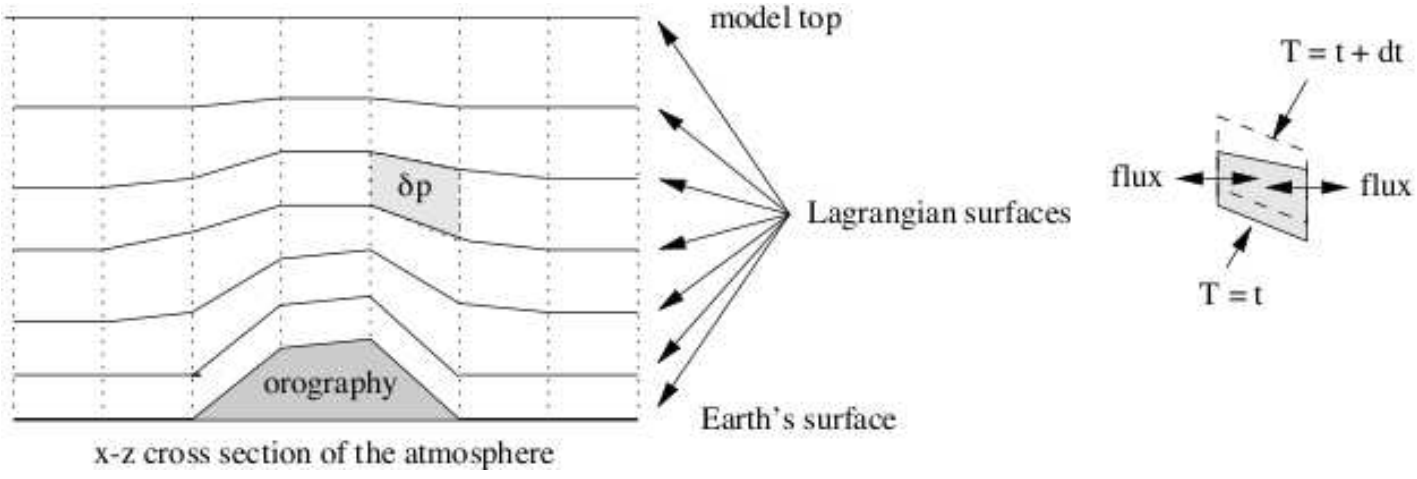
Finite-Volume Numerics

- Lin-Rood scheme used in the horizontal
  - conservative
  - long time step (ffsl)
  - uses 1D methods
  - (almost) monotonic
- Explicit timestep
- Piecewise Parabolic Method (PPM) algorithm used to calculate fluxes
- Uses both C and D grids



Lagrangian Vertical Coordinate

- Floating vertical levels remapped to reference grid - this replaces vertical advection in the model
- Different timesteps for dynamics, tracers and vertical remapping



Dissipation, Filters and Fixers

- Design philosophy: be diffusive rather than dispersive
- Implicit diffusion from PPM:
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- Also uses
  - polar filter to remove fast gravity waves
  - sponge layer at the model top
  - optional energy fixer to replace energy lost due to dissipation

Summary

- CAM-FV uses finite-volume numerics, a vertical Lagrangian coordinate, and the lat-lon grid
- Conservative and consistent
- Designed with the focus on accurate transport